New Facility Example: LANDFILL PSD EXAMPLE #1

PROPOSED PROJECT:

A landfill, currently with no air quality permits required, decides to install a new landfill gas extraction and purification system. The project consists of the following emitting units:

- *Two (2) 349-bhp generator engines – 80 standard cubic feet per minute in each engine with the following gas composition:*
  60mol% CH_4 (Methane)
  39mol% CO_2 (carbon dioxide)
  0.5mol% NMOC (non-methane organic compounds)
  0.5mol% O_2 (Oxygen)
  612 Btu/scfm
  Guaranteed CO Emissions Rate = 0.006 lb/bhp-hr (exceeds 40 CFR 60 Subpart JJJJ Requirements)
  VOC emissions rate of 0.22 lb/MMbtu

- *One (1) Flare – 2,400 standard cubic feet per minute (scfm) of 54 mol% CH_4*

- *One (1) Propane assisted Thermal Oxidizer - 1,579 scfm of 15 mol% CH_4*

Max PTE of Conventional Pollutants Determined to be:

- PM/PM10/PM2.5: 5.11 TPY
- NO_X: 25.49 TPY
- CO: 46.25 TPY
- VOC: 22.55 TPY
- SO_2: 6.61 TPY

What would be the GHG related PSD and Title V Permitting Requirements associated with this project

1.) If the MAQP is going to go Decision between 1/2/2010 and 7/1/2011 (STEP 1 of the Tailoring Rule) ANSWER: Not a PSD or Title V 'Anyway' source!
2.) If the MAQP is going to go Decision after 7/1/2011 (STEP 2 of the Tailoring Rule)

Question 1: On a mass basis, what are the total emissions of ghgs (mass basis)?

Step 1: Identify and quantify emissions of ghg's that are present from the generator engines, flare, thermal oxidizer, and fugitive emissions (from leaks) from system:

- The greenhouse gases associated with combustion would be expected:
  - Carbon Dioxide (CO_2)
  - Methane (CH_4)

- Nitrous Oxide (N_2O)

- CH_4 and CO_2 are also present in the landfill gas itself

- Some useful resources for emissions factors:
  - AP-42 - http://www.epa.gov/ttn/chief/ap42/
  - Intergovernmental Panel on Climate Change (IPCC) Emission Factor Database: http://www.ipcc-nggip.iges.or.jp/EFDB/main.php
  - Emission Inventory Improvement Program (EIIP) documents
  - Manufacturer/Vendor Information (remember de-minimis implications)

. . . Remember, control equipment oxidizing CO to CO_2 results in higher CO_2 emissions. Be careful to use emissions factors that are appropriate. i.e. – The AP-42 emissions factor for uncontrolled engines for CO_2 would not be appropriate for these generator engines (nor would it be appropriate for CO!). Ask vendors/manufacturers to provide appropriate emissions factors for your projects when possible! See attached for an example of a mass balance calculation approach which would be one way to quantify emissions should all else fail.

Generator Engines:
CO_2: 2,372 tons per year (TPY) per engine
CH_4: 16 TPY per engine
N_2O: 11 TPY per engine
Flare:
CO_2: 62,613 TPY
CH_4: 55 TPY
N_2O: 30 TPY

Thermal Oxidizer:
CO_2: 48,613 TPY
CH_4: 43 TPY
N2O: 23 TPY

Step 2: Add all emissions to obtain project total:

$\sum CO_2 + \sum CH_4 + \sum N_2O$ = Project's Total Emissions of ghg's (mass basis)

In this case, it's pretty obvious the total emissions of ghg's (mass basis) will be greater than 250 TPY. However, you will need to quantify the emissions for any application (see question 2 below).

$\sum CO_2$ = (2,372*2 engines) + 62,613 + 48,613 = 115,970 TPY
$\sum CH_4$ = 16 + 55 + 43 = 114
$\sum N_2O$ = 11 + 30 + 23 = 64

The project's ghg emissions (mass basis) is: 115,970 + 114 + 64 = 116,148 TPY

Question 2: What are the total emissions of CO_2e ?

Step 1: Refer to Global Warming Potential Table (Title 40, Part 98, Subpart A, Table A-1)
Step 2: Identify pollutants and their respective GWPs.

Pollutant	Global Warming Potential
CO_2	1
CH_4	21
N_2O	310

Step 3: $CO_2e(TPY) = \sum_i (GWP_i \times MassEmissionRate_i(tpy))$

$CO_2e(TPY) = (Total\ CO_2 * 1) + (Total\ CH_4 * 21) + (Total\ N_2O * 310)$

$CO2e(TPY) = (115{,}970 * 1) + (114 * 21) + (64 * 310) =$ <u>138,204 TPY</u>

Question 3: Is the facility going to be considered a Major Stationary Source?

This is not a listed source, so the major source threshold in terms of PSD is 250 TPY. This is a new project, so we want to know if the source is going to be a major source (major modification and netting is not applicable yet). So, the question is:

1.) Are any conventional pollutants greater than 250 TPY?

NO

2.) Is the sum of ghg's on a mass basis > 250 TPY <u>AND</u> is the total emissions of CO_2e greater than 100,000 TPY?

YES

<u>PSD APPLICABILITY ANALYSIS:</u>

Under Step 1 of the tailoring rule (MAQP going decision before 7/2/2011):

The facility is not a 'PSD Anyway' Source. Therefore, PSD does not apply.

Under Step 2 of the tailoring rule:

The facility will be considered a Major Stationary Source. PSD applies. Because the facility triggers PSD for GHG, will also need to do PSD analyses for any pollutant over the Significant Emissions Rates (see SER handout).

- Max PTE of $PM/PM_{10}/PM_{2.5}$ is 5.11 TPY (< SER of 25/15 TPY)
- Max PTE of NO_X is 25.49 TPY (<SER of 40 TPY)
- Max PTE of CO is 46.25 TPY (<SER of 100 TPY)
- Max PTE of VOC is 22.55 TPY (<SER of 40 TPY)
- Max PTE of SO_2 is 6.61 TPY (<SER of 40 TPY)

All pollutants above are less than the SERs, therefore, they are not subject to PSD.

<u>Remember, there is no ambient air quality standard for GHG, and this is a new source, so this is not a very complicated PSD action!</u> This permitting action will be subject to PSD BACT (Best Available Control Technology) for GHGs.

LANDFILL PSD EXAMPLE #2

PROPOSED PROJECT:

The same landfill described in Landfill Example #1 and having been already permitted under Step 2 of the Tailoring Rule, proposes a modification to their process. They are thinking about removing the two 349-bhp engines, and adding one 850-bhp engine.

The facility also previously had an addition qualifying as a de minimis action in which a small back-up generator was added. (by the way – important to note is that circumvention of PSD is illegal, but that is not the case here – they already went through PSD).

Engine PTE of CO_2e:
5,780 TPY of CO_2e

Fugitive Emissions Increases:
10 TPY CO_2 and 20 TPY CH_4

De minimis increase:
800 TPY of CO_2e was associated with this

The maximum potential to emit of all criteria pollutants are determined to remain below 100 TPY.

Determine PSD Applicability Under Step 2 of Tailoring Rule on your own (Analysis provided on next page):

PSD Applicability Analysis:

This is potentially subject to PSD for NO_X only (over the SER)

Key points of the analyses for PSD applicability:

- The GHG emissions increase does not meet the criteria of being a major modification (it is not major unto itself). 5,780 TPY of CO_2e + 10 TPY of CO_2 + (21*20 TPY of CH_4) = **6,210 TPY CO_2e**. The emissions increase itself is less than 75,000 TPY of CO_2 (has 6,210 TPY CO_2), although it meets the other qualifier of >0 TPY of a GHG.
    - MAJOR MODIFICATION =

      Net Emissions Increase of 75,000 TPY of CO_2e
      AND
      >0 Net Emissions Increase of ghg on a mass basis.

- The modification is not major unto itself in terms of GHG – so it does not make sense to look at netting. From a netting perspective, it would be determined to not be a major modification.

- NO_X would be over 40 TPY, the SER, so netting for NO_X would likely be desirable. From a netting perspective, NO_X would likely fall out of PSD permitting. (p.s. - the project is not located within 10 km of any Class I area, nor a non-attainment area. - ANY increase of a pollutant, from a Major source, located in or within 10 km of a class I area, is subject to modeling to ensure no increase greater than 1 ug/m^3. Any source located in or within 10 km of a non-attainment area would probably want to model to show they are not causing or contributing to non-attainment area.

- The facility's overall CO_2e would remain greater than 100,000 TPY AND the facility has the potential-to-emit greater than 250 TPY of ghgs (mass basis) – so it is still a major stationary source. No Major Modification occurred, therefore, no PSD analyses are required. This increase will be subject to inclusion in netting considerations in the future for the next 5 years.

New Facility Example: LANDFILL TITLE V EXAMPLE #1
PROPOSED PROJECT: *A landfill, currently with no air quality permits required, decides to install a new landfill gas extraction and purification system. The project consists of the following emitting units:* • *Two (2) 349-bhp generator engines – 80 standard cubic feet per minute in each engine with the following gas composition:* *60mol% CH_4 (Methane)* *39mol% CO_2 (carbon dioxide)* *0.5mol% NMOC (non-methane organic compounds)* *0.5mol% O_2 (Oxygen)* *612 Btu/scfm* *Guaranteed CO Emissions Rate = 0.006 lb/bhp-hr (exceeds 40 CFR 60 Subpart JJJJ Requirements)* *VOC emissions rate of 0.22 lb/MMbtu* • *One (1) Flare – 2,400 standard cubic feet per minute (scfm) of 54 mol% CH_4* • *One (1) Propane assisted Thermal Oxidizer - 1,579 scfm of 15 mol% CH_4*
Max PTE of Conventional Pollutants Determined to be: • PM/PM10/PM2.5: 5.11 TPY • NO_X: 25.49 TPY • CO: 46.25 TPY • VOC: 22.55 TPY • SO_2: 6.61 TPY

Question 1: On a mass basis, what are the total emissions of ghgs (mass basis)?

Question 2: What are the total emissions of CO_2e ?

Question 3: Is the facility going to be determined a Title V Source?

- Are any conventional pollutants greater than 100 TPY?

  NO

- Is the sum of ghg's on a mass basis > 100 TPY AND is the total emissions of CO_2e greater than 100,000 TPY?

YES

TITLE V ANALYSIS

Step 1 of Tailoring Rule:

The source is not a 'Title V Anyway' source; therefore, it is not subject to Title V. However, within one year after commencement of operation, or one year after Step 2 of the Tailoring Rule (whichever is later), this source would need to apply for a Title V permit.

Step 2 of the Tailoring Rule:

The action is subject to Title V. The PTE of CO_2e is greater than 100,000 TPY AND the PTE of ghg (mass basis) is greater than 100 TPY.

LANDFILL TITLE V EXAMPLE #2
PROPOSED PROJECT: *The same landfill described in Landfill Example #1 and having been already permitted under Step 2 of the Tailoring Rule, proposes a modification to their process. They are thinking about removing the two 349-bhp engines, and adding one 850-bhp engine.* *The facility also previously had an addition qualifying as a de minimis action in which a small back-up generator was added. (by the way – important to note is that circumvention of PSD is illegal, but that is not the case here – they already went through PSD).*
Engine PTE of CO_2e: 5,780 TPY of CO_2e Fugitive Emissions Increases: 10 TPY CO_2 and 20 TPY CH_4 De minimis increase: 800 TPY of CO_2e was associated with this The maximum potential to emit of all criteria pollutants are determined to remain below 100 TPY.

DETERMINE TITLE V ON YOUR OWN

TITLE V APPLICABILITY

The source is already subject to Title V. An update to the MAQP is required as always, and the Title V will need to be updated as a result. Nothing different is done because of GHG in this case.

Example Calculations:

In the absence of an appropriate CO_2 emissions factor, one way to calculate the CO_2 emissions is from a mass balance approach (ugg! Try not to have to do this!). The following is an example for LFG, so results will be different than for pipeline quality natural gas. We will probably not review this in detail – the point is – make your life easier and get manufacturer supplied emissions factors!!

Compound	Molecular Weight	*	mol% of LFG		
CH_4	16.05 lb/lbmol	*	60%	=	9.63
CO_2	44.01 lb/lbmol	*	39%	=	17.16
NMOC	31 lb/lbmol	*	0.5%	=	0.25
O_2	32 lb/lbmol	*	0.5%	=	0.16
Molecular Weight of LFG				=	***27.2 lb/lbmol***

80 scfm = 42,048,000 scfy

42,048,000 ft^3/yr*(1/10.73) R-lbmol/ft^3-psi*14.7 psia*(1/520R) = **110,780 lbmol/yr LFG**

CH_4 in
110,780 lbmol/yr * 60% CH_4 = 66,468 lbmol CH_4
66,468 lbmol CH_4 * 16.05 lb/lbmol = 1066811 lbs CH_4 * (12.01/16.05) **= 798,280 lbs/yr C**

CO_2 in
110,780 lbmol/yr * 39% CO_2 = 43,204 lbmol CO_2
43,204 lbmol CO_2 * 44.01 lb/lbmol = 1901417 lbs CO_2 * (12.01/44.01) **= 518,882 lbs/yr C**

NMOC in
110,780 lbmol/yr * 0.5% NMOC = 553.9 lbs NMOC * (12.01/31) = **215 lbs/yr C**

O_2 in – No Carbon

TOTAL CARBON GOING IN: 1,317,377 lb/yr C

CO Out
CO emissions rate = 0.006 lb/bhp-hr*349 bhp*8760 hr/yr = 18,343 lb/yr CO
18,343 lb/yr * (12.01/28.01) = **7,865 lb/yr C going out in CO**

NMOC Out

VOC emissions rate= 0.22 lb/MMBtu*600Btu/scfm*10^-6
MMBtu/Btu*80scfm*60min/hr*8760hr/yr=5550lb/yr
5,550 lb/yr * (12.01/31) = **2131 lb/yr C going out in VOC**

1317377 – 18343 – 2131 = 1,296,903 lbs/yr C going out as CO_2

1296903 * (44.01/12.01) = 4,752,431 lbs/yr of CO2 = *2,372 TPY CO_2 Emitted (per engine)*

FLARE

- Concentration of CH_4 in the LFG going to the flare is 54mol%
- Assume concentration of CO_2 in the LFG going to the flare is 45mol%
- 2,400 scfm going to flare

AP-42 2.4-1 - DRAFT 10/08

$$CM_{CO_2} = UM_{CO_2} + \left(UM_{CH_4} \times \frac{\eta_{col}}{100} \times 2.75 \right) \quad (6)$$

where:

CM_{CO_2} = Controlled mass emissions of CO_2, kg/yr;
UM_{CO_2} = Uncontrolled mass emissions of CO_2, kg/yr (from Equation 4);
UM_{CH_4} = Uncontrolled mass emissions of CH_4, kg/yr (from Equation 4);
η_{col} = Efficiency of the LFG collection system, % (recommended default is 75%);
and
2.75 = Ratio of the molecular weight of CO_2 to the molecular weight of CH_4.

We know UM_{CO2} and UM_{CH4} from information given, SO:

2,400 scfm = 1,261,440,000 scfy

1,261,440,000 scfy*(1/10.73) R-lbmol/ft^3-psi*14.7 psia*(1/520R) = 3,323,387 lbmol LFG to flare

UM_{CO2} = 45mol%*3,323,387 lbmol/yr = 1,495,524 lbmol/yr CO_2
= 65,818,010 lb CO_2 = 32,909 TPY = **29,854,547 kg/yr**

UM_{CH4} = 54mol%*3,323,387 lbmol/yr = 1,794,629 lbmol/yr CO_2
= 28,803,792 lb CH_4 = 14,402 TPY = **13,065,180 kg/yr**

CM_{CO2} = **29854547** + (**13065180** x 0.75 x 2.75) = 56,801,481 kg/yr = ***62,613 TPY CO_2***

Propane assisted Thermal Oxidizer (TO)

- 1,579 scfm max LFG to TO
- CH_4 = 15mol%
- 0.843 gal/min Propane required
- Assume 84 mol% CO_2

Calculate based on CH_4 first, then the propane, and then add all together

CH_4 Portion of Combustion

1,579 scfm = 829,922,400 scfy

829,922,400 scfy*(1/10.73) R-lbmol/ft^3-psi*14.7 psia*(1/520R) = 2,186,511 lbmol LFG to flare
2,186,511*15% = 327,977 lbmol CH_4 = 5,264,026 lbs = 2,387,722 kg CH_4

2,186,511*84% = 1,836,670 lbmol CO_2 = 80,831,830 lbs = 36,664,701 kg CO_2

CM_{CO2} = 36664701 + (2387722*0.75*2.75) = 41,589,378 kg CO_2 = 91,688,883 lb = **45,844 TPY**

Propane Portion of Combustion

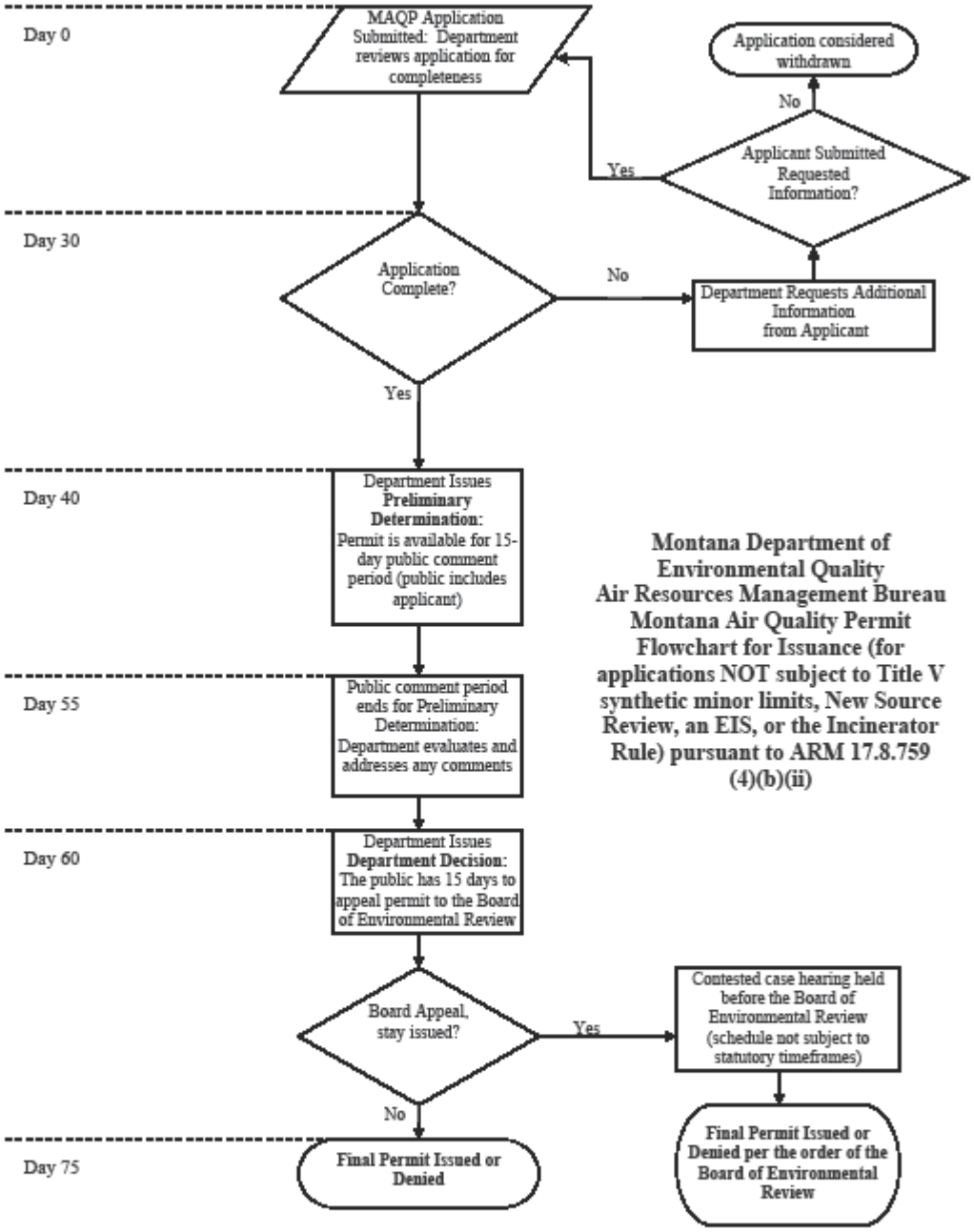
CO_2 emissions factor (AP-42 Table 1.5-1, 07/2008) – 12,500 lb/10^3 gal.

0.843 gal/min = 443081 gal/yr
443*10^3 gal/yr*12,500 lb/10^3 gal = 5,537,500 lb/yr = **2,769TPY**

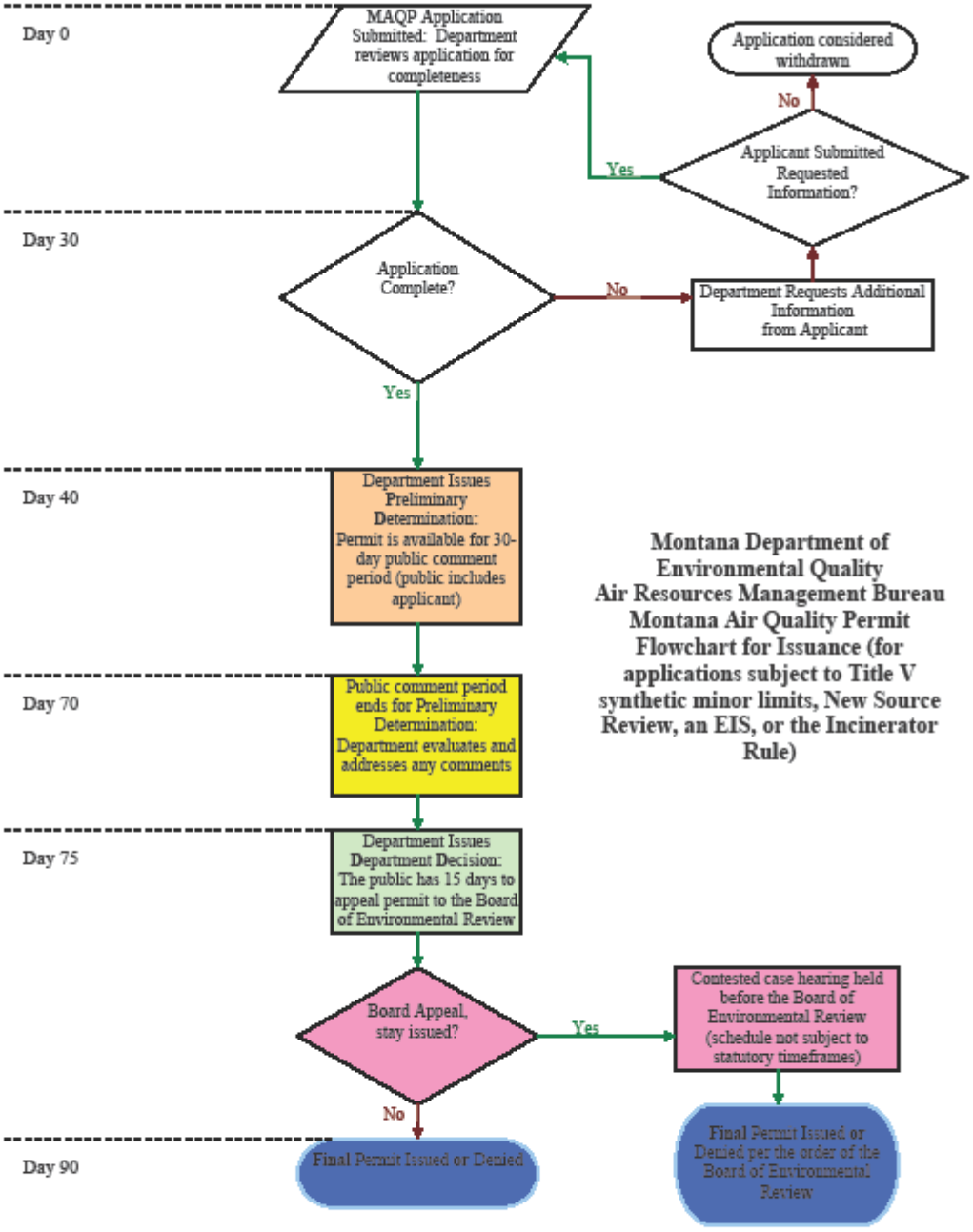
TOTAL CO_2 = 45,844 + 2769 = *48,613 TPY*

TOTAL CO_2 for Project = Engines + Flare + Thermal Oxidizer
= 4,744 TPY + 62,613 TPY + 48,613 TPY =

115,970 TPY CO_2



Montana Department of Environmental Quality
Air Resources Management Bureau
Montana Air Quality Permit Flowchart for Issuance (for applications NOT subject to Title V synthetic minor limits, New Source Review, an EIS, or the Incinerator Rule) pursuant to ARM 17.8.759 (4)(b)(ii)



Montana Department of Environmental Quality
Air Resources Management Bureau
Montana Air Quality Permit Flowchart for Issuance (for applications subject to Title V synthetic minor limits, New Source Review, an EIS, or the Incinerator Rule)

G:\ARMB\AQPERMIT\PRECONS\FORMS\MAQP_flowchart_30.doc 10/24/08